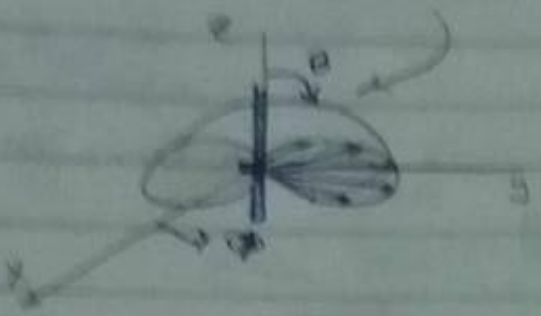
١٣/١٢/٢٠١٣ lec د. فهد

Antenna Patterns
or Radiation Pattern

Pattern is a 3D Plot That determines The Antenna characteristics



رسم ثلاثي الابعاد يحدد اخصائص هوائي

نوجد كيف لانتينا تشع من Pattern

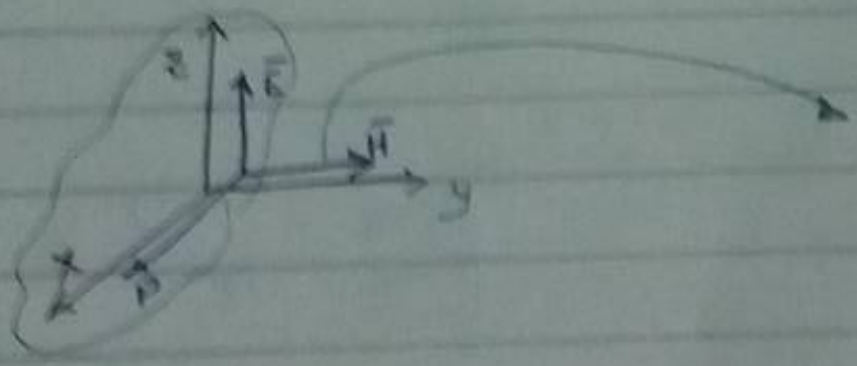
* They are infinite number of Planes To represent The Antenna Pattern.
* The Most Commonly used Patterns are :

E Plane Pattern

* is The Plane That Contains The electric Field and The direction of Propagation

H Plane Pattern

* is The plane That Contains The Magnetic Field and The direction of Propagation



X-y. Plane

X-z. Plane

Special Cases for dipoles and Mono Poles

E-Plane → is the plane in which the antenna appear with its true length

y-z and x-z

H-Plane → is the plane in which the antenna appear as a point x-y

Example

for infinitismal dipole plot its radiation pattern

* Electric field pattern

$$E_\theta = \frac{j\omega M}{4\pi} I_o \Delta L \frac{e^{-j\beta r}}{r} \sin\theta$$

$$|E_\theta| = \left(\frac{\omega M}{4\pi r} I_o \Delta L\right) \sin\theta$$

E_o

$$|E_\theta| = E_o \sin\theta$$

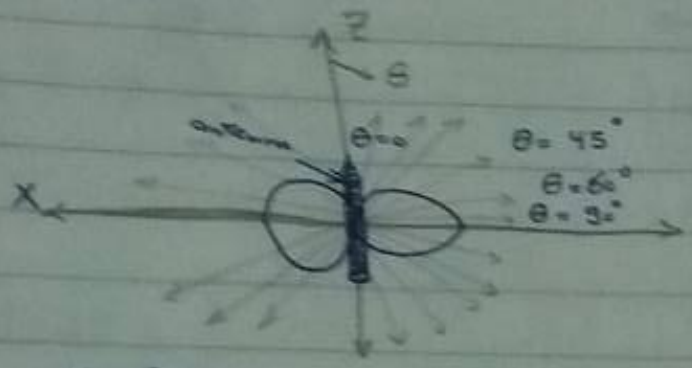
$$* \; |E_\theta|_n = \sin\theta$$

as in figure ① The antenna is directed in Z-direction Plot the field Pattern

① for ⇒ E-Plane

(X-Z) or (θ = ✓ , ϕ = 0)

$|E_\theta|_{n(\theta,\phi)} = \sin\theta$

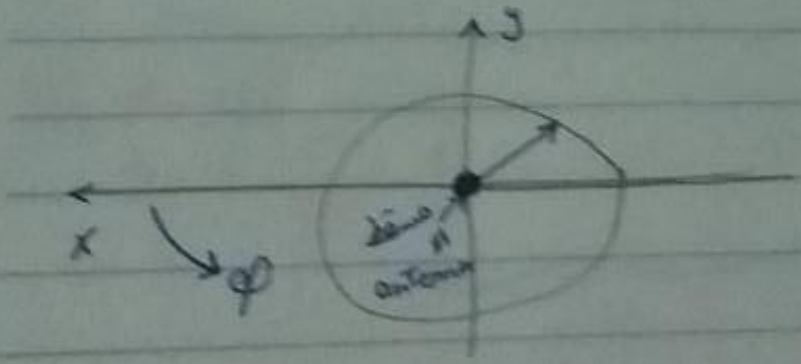


8-figure

→ H-Plane → (X-y plane)

($\theta = 90$, ϕ = ✓)

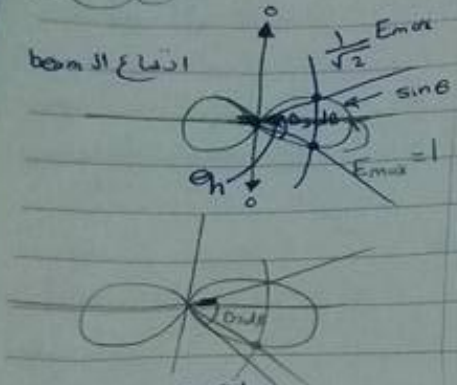
$|E_\theta|_{n(\theta=90,\phi=\checkmark)} = \sin\theta = 1$



(١٥) half Power Beam Width (HPBW) or ($\Delta 3dB$)
(١١) Null To Null beam Width Δ_{N-N}

$\Delta 3dB$

$\Delta_{N-N} = 180^\circ$



$\Delta 3dB = 2\theta_{half}$

$\sin\theta_n = \frac{1}{\sqrt{2}} E_{max}$ (=1)

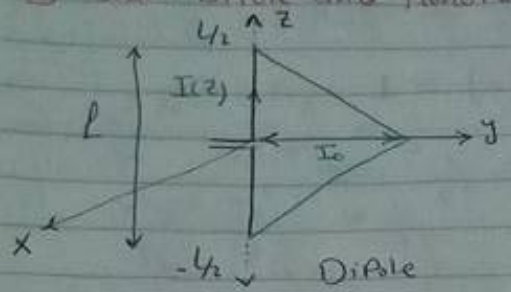
$\sin\theta_n = \frac{1}{\sqrt{2}}$

$\theta_n = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45^\circ$

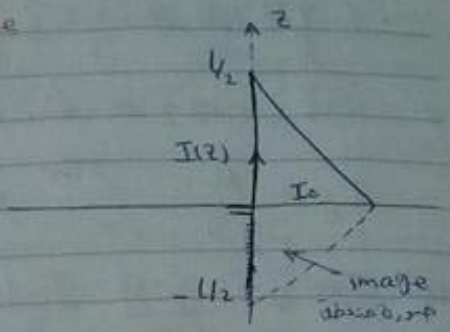
$\Delta 3dB = 90$

*

[2] Short Dipole and Monopole



Dipole



Short Monopole

* $L \geq \frac{\lambda}{10}$

* The current distribution is Triangular shape

$$I(z) = \begin{cases} I_0 + \frac{2I_0 z}{l} & -\frac{l}{2} \leq z \leq 0 \\ I_0 - \frac{2I_0 z}{l} & 0 \leq z \leq \frac{l}{2} \\ 0 & \text{o.w} \end{cases}$$

$$I(z) = I_0 \, Tri\left(\frac{z}{(l/2)}\right)$$

↳ half width

$A\,Tri\left(\frac{\tau}{\tau/2}\right)$

[1] $A_z = ??$

$$A_z = \frac{\mu}{4\pi} \frac{e^{-j\beta r}}{r} F.T\left[I(z)\right]$$

$A\,Tri\left(\frac{\tau}{2}\right) \rightarrow A\tau\, Sa^2\left(\frac{\omega\tau}{2}\right)$

$$= \frac{\mu}{4\pi} \frac{e^{-j\beta r}}{r} \left[I_0 \frac{L}{2} Sa^2\left(\frac{\omega L/2}{2}\right)\right]$$

$\omega = \beta \cos\theta$

اسئلة ال ω

$$\frac{\omega l}{2} = \frac{\omega l}{4} = \frac{\beta \cos\theta \, l}{4}$$

$$= \frac{2\pi}{\lambda} \cos\theta \frac{1}{4} \times \frac{\lambda}{10} = \frac{\pi}{20} = 0.15$$

$$Sa^2(0.15) \simeq Sa^2(0) \simeq 1$$

$$A_z = \frac{\mu}{4\pi} \frac{e^{-j\beta r}}{r} I_0 \frac{l}{2} \quad \#$$

[2] $$E_\theta = \frac{j\omega\mu}{4\pi} \frac{I_0 l}{2} \frac{e^{-j\beta r}}{r} \sin\theta \quad \#$$

$$|E_\theta| = \frac{\omega\mu}{4\pi r} \frac{I_0 l}{2} \sin\theta \quad \#$$

[3] $$H_\phi = \frac{1}{\eta} E_\theta \quad \#$$

Poynting

[1] $$\bar{P}_{av} = \frac{1}{2} Re\left[\bar{E} \times \bar{H}^*\right]$$

$$= \frac{1}{2} Re\left[\bar{E}_\theta * \bar{H}_\phi^*\right]$$

$$= \frac{1}{2\eta} |E_\theta|^2$$

$$\bar{P}_{av} = \frac{1}{2\eta} \frac{\omega^2\mu^2}{16\pi^2} \frac{I_0^2 l^2}{4} \sin^2\theta \quad W/m^2 \quad \#$$

[2] $$W_{rad} = \int_0^{2\pi} \int_0^{\pi} \bar{P}_{av} r^2 \sin\theta \, d\theta \, d\phi$$

$$= \int_0^{2\pi} \int_0^{\pi} \frac{1}{2\eta} * \frac{\omega^2\mu^2}{16\pi^2} \frac{I_0^2 l^2}{4r^2} \sin^2\theta \, r^2 \sin\theta \, d\theta \, d\phi$$

$$= 2\pi \frac{1}{2\eta} \frac{\omega^2 \mu^2}{16\pi^2} \frac{I_o^2 l^2}{4} \int_0^{\pi} \sin^3\theta \, d\theta$$

$\pi/3$

$$= \frac{\omega^2 \mu^2}{4} \frac{I_o^2 l^2}{16\pi} * \frac{1}{3}$$

$$= \frac{4^2 \beta^2}{4} \frac{I_o^2 l^2}{16\pi} * \frac{1}{3}$$

$$= 120\pi \frac{4\pi^2}{\lambda^2} \frac{I_o^2 l^2}{16\pi} * \frac{1}{3}$$

$$= 10\pi^2 I_o^2 \left(\frac{l}{\lambda}\right)^2$$

$$W_{rad} = 10\pi^2 I_o^2 \left(\frac{l}{\lambda}\right)^2$$

WaT # ولا ؟

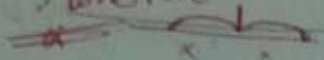
$$I_o = \sqrt{2}\, I_{rms}$$

$$W_{rad} = 20\pi^2 I_{rms}^2 \left(\frac{l}{\lambda}\right)^2 \quad \#$$

(3) $$R_{rad} = \frac{W_{rad}}{I_{rms}^2} = 20\pi^2 \left(\frac{l}{\lambda}\right)^2 \#$$

في حالة Monopole

* $W_{rad_{Mono}} = \frac{W_{rad}}{2}$



* $R_{rad_{Mono}} = \frac{R_{rad}}{2}$